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DESIGN AND FABRICATION OF STEERING SYSTEM FOR SOLAR ELECTRICAL VEHICLE

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Abstract :In this current era where everyone is concern about the availability of Fossil Fuels, solar vehicle is another alternative as it comes under renewable sources of energy. The solar powered electric vehicle is also considered, because of less noise, less pollution and reduces greenhouse gas emission (GHG) emission. In this paper a virtual prototype of linkage assembly with complete geometry is proposed to enhance and facilitate steering response of an Electric-Solar Vehicle by varying the different parameters employed during its design and manufacturing. It is important to know how the different aspects like steering ratio, pinion diameter, rack length etc. govern the working of the mechanism. The geometrical analysis of the steering mechanism is successfully done.

***IndexTerms*–Hybrid Electric Vehicle, Ackerman Steering, Photo-Voltaic Cell.**

I. INTRODUCTION

A zero-emission vehicle is powered by Solar energy by means of solar photovoltaic panels through storage batteries and the traction is obtained by an electric motor. But, solar energy for electric Vehicle is not an issue, because several critical points also need to be analyzed. For example, the efficiency and costs of solar photovoltaic panels, how to maximize the solar irradiation, and the control and energy management. Nowadays, there are many researchers developing solar vehicle around the world for various purposes. Latest innovations are highlights on the solar photovoltaic powered, zero-emission electric vehicle and solar/wind powered hybrid electric Vehicle, with an internal combustion engine was proposed.

A hybrid system for an electric Vehicle is proposed, including solar photovoltaic, storage battery and super capacitor, with the system configuration and different control strategy. The vehicle involving battery powered and charged by photovoltaic panels is used for agricultural activities in remote hilly areas, with the aim to produce the cleaner power hence the usage of diesel is reduced in agriculture. Other hand, many solar vehicles are built to participate in different solar vehicle championship around the world to test and examine the new technological advancements and its potential to design the zero-emission vehicles.

The design and development of electric solar vehicle is an initiative for students and researchers of various domains, motivated by solar vehicles. The solar vehicle is another step to save the non-renewable sources of energy. The solar powered electric vehicle is also considered, because of less noise, less pollution and reduces greenhouse gas emission (GHG) emission. Electric vehicle consists of photovoltaic panel, charger controller, battery, electronic speed controller and Brushless DC motor.

Selection of appropriate e-propulsion system for three-wheeled e-vehicle is a crucial step as each motor i.e. DC, IM, SR BLDC motor has merit and demerits associated with it. The e-propulsion motor must have high efficiency, high starting torque, high torque at low speed, high power density, fast dynamic response, high reliability, longer life, low maintenance cost, simple controlling and cost-effective etc. In order to choose proper motor for three-wheeler e-vehicle, a grading system from 1 to 5 is designed where 1 indicates worst and 5 indicates excellent based on test performance on IM, DC, SR BLDC motors. Technical evaluation parameters such as efficiency, torque, reliability, dynamic response cost etc. are computed and assigned the corresponding grade values based on the tests performed on these motors.

Different mechanical based four-wheel system already existing in vehicle is: The bevel gear is used in the four-wheel steering mechanism. As two bevel gears are considered, one bevel gear is attached to the steering column of the front steering box and the other bevel gear is attached toothed intermediate shaft. Use of bevel gear causes system more expensive, while it should be precisely mounted to avoid wear of tyre. Along with bevel gear universal joints with steering knuckle are used.

The car steering system in the automobile is the process of running the vehicle in the desired direction by turning, usually the front wheels. For effective control of the vehicle throughout its speed range with safety, proper steering is necessary. The system allows a driver to use only light forces to steer a heavy car. Steering is also possible by the turning of the rear wheels, which is used generally in low-speed slow-floor vehicles, for lifting and transporting heavy parts to a short distance for example forklift.

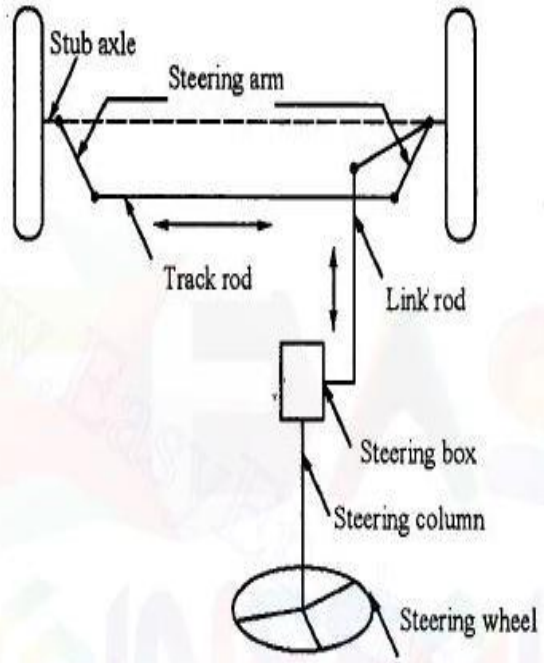

Figure 1.1 Layout of steering system

The objective of the proposed design is, the energy drawn from the solar panel should be used to charge a battery which runs the motor of the vehicle. A simple DC converter acts as interface between the solar panel and the battery to obtain the required constant voltage and it will extract maximum power from solar photovoltaic panel.

In this report a virtual prototype of linkage assembly with complete geometry is proposed to enhance and facilitate steering response of an Electric-Solar Vehicle by varying the different parameters employed during its design and manufacturing. It is important to know how the different aspects like steering ratio, pinion diameter, rack length etc. govern the working of the mechanism. The geometrical analysis of the steering mechanism is successfully done. According to Steering geometry, the outer wheels moves faster than the inner wheels, therefore, the equation for correct steering.

The intention of geometry is to prevent the tyres from slipping outwards when the wheels follow around a curve while taking a turn. The solution for this is that all wheels to have their axles settled as radii of circles with a common Centre point. Since the rear wheels are fixed, this centre point must lie on a line extended from the rear axle. So we need to intersect the front axle to this line at the common center point as shown in. While steering, the inner wheel angle is greater than outer wheel angle. So for obtaining different results we need to vary the parameters in order to obtain desired steering geometry.

1.1 Need for Steering Mechanism

There is a fixed turning radius for every vehicle, which is the space it requires to complete a circle. The radius is calculated from an imaginary centre point called the centre of turning radius. If you observe your car‟s wheel while turning, you can notice that the inner wheel is closer to the centre of the turning radius when compared to the outer wheel. Also, the inner wheel has to take a shorter turn, and the outer wheel has to take a long turn when compared to the inner wheel. In this case, if both wheels are turned at the same angle, there may be a possibility of slipping. But why the slip happens?

In order to understand this, you must first understand how a wheel works. A wheel has two different types of velocity. One is the rotational velocity, and the other is the translational velocity. They both have equal magnitude but are opposite in direction; hence they cancel each other. When the wheel has turned, the direction of the rotational velocity changes and there may be a possibility of slip. To avoid that slip, the direction of the translational velocity has to be changed. But, there arises an issue. While turning your car, the inner wheel travels a small distance and need less translational velocity compared to the outer wheel. So, both wheels must have different translational velocities and different directions for rotational velocity. This difficulty could be overcome by having different steering angles for two front wheels.

II. Literature Survey

An electric-solar car is an electric vehicle powered completely or significantly by direct solar energy using the photovoltaic cell. The analysis and understanding of electrical and photovoltaic systems seems to be highly intuitive for fabrication of successful design of prototype. The main aim and focus of our project is to design and analysis an effective steering system for electric-solar vehicle. Ackerman steering principle is taken as the consideration of steering mechanism [2]. The steering effort is applied to steering wheel to rotate rack shaft that is attached with pinion gear which convert rotary motion into linear motion through rack and

pinion steering mechanism helps in smooth steering of vehicle. Report includes complete theory and procedure adopted for selecting the parameters and materials for the designing of rack and pinion model for the steering system.

Mulhall et al. developed a solar powered assisted three-wheeler electric auto rickshaw to overcome the pollution issues and scarcity of fossil fuel resources for developing country like India[1]. The results show that the performance of the proposed electric auto rickshaw is far better than a conventional rickshaw.

A four-wheeled solar hybrid vehicle (SHV) model that utilizes renewable solar PV technology is proposed. Various components such as electric motor, management unit, PV panels, and power batteries are used for the proposed vehicle model. Another, four-wheeler solar electric vehicle that utilizes the solar insolation, directly and indirectly, is presented [3]. A four-wheeler solar electric vehicle having one person seating capacity is developed. Design and development of an eco-friendly solar electric car are proposed [4]. A model (Kundi) of the four-wheeled solar electric vehicle has been developed in China. Flexible solar panels, 7.5 KW 72 V electric motor and 130 Ah battery system has been employed in this car [5].

Optimal solar tracking and electrical power system are designed for a four-wheeler solar electric vehicle. A bi-directional DC converter is employed for a solar powered four-wheeled vehicle that utilizes regenerative braking energy to recharge battery storage systems [6]. Designing and development of an electrical power system that utilizes the PV panels to extract solar energy and converts into useful electricity for a solar vehicle are presented.

III. METHODOLOGY

From the flow chart, this project started with the objective of the project. The objective of the project must follow the title. The objective must fulfill the title, then follow up with design review about folding table and then study a lot of investigation about folding table. This is including study about several of stage, type of stage, types of material which suitable to make a stage. These tasks have been done through study on internet, books and others resources.

After all information had been collected and gathered, the project continued with the design process. All the knowledge and lessons had been applied to make a suitable design for the project. After several design sketched, design consideration have been made and one of the design have been chosen by using Pugh‟s concept selection.

The solid modeling and engineering drawing by using solid works software the fabrication process progress use drawing as a reference. The process consist fabrication to all parts that have been designed by the dimension using various type of manufacturing process. The manufacturing process includes welding, drilling, bending, cutting and etc. During the fabrication process, if there have error occur, such as fabrication error, so the process need to modification the process need to go back to the previous step and the process flow again, until no error occur the process can been continued smoothly until the final product finished. Then, the draft report need to be submitted to the supervisor for double checking if there had an error.

IV. CAED MODEL AND ASSEMBLY

SolidWorks software is used for modelling the existing and modified chassis of the electric vehicle. After that, AISI 1033 steel is considered the material for solar powered e-vehicle and meshing CAD models of existing and modified chassis are created. Vertical and longitudinal loads are computed for these chassis. Thereafter, CAD models of chassis are analysed to compute force reaction, moment reaction, equivalent stresses, inertial relief translational and rotational acceleration to counterbalanced the applied external loads. Finally, undertaken a comparison between existing and modified chassis results.

Longitudinal Vehicle Dynamic (LVD) model is developed to examine the accuracy and validity of the Simscape physical model of three-wheeled e-vehicle presented in the previous chapter. LVD model of three-wheeled e-vehicle is derived from the dynamic model of a vehicle having six-degree of freedom autonomy. First, dynamic motion equations of the tractive effort and torque applied to the rear wheels of three-wheeled e-vehicle are formulated. Thereafter, the dynamic load acting on the front wheel and the rear are derived for LVD model of a three-wheeled vehicle. Further, derived equations of torque, dynamic loads acting on vehicle are coded in MATLAB® programming environment. Thereafter, mechanical design parameters for the three-wheeled vehicle are assigned to the coded equations. Further, simulations have been performed for LVD model of the three-wheeled hybrid electric vehicle at different road gradient conditions. After that, compute the mean value of torque and vertical loads acting on a three-wheeled vehicle. Finally, undertaken a comparison between results of LVD model and Simscape models.

Figure 4.1 CAED model of the chassis frame

The parts of the steering system assembly are part of the free solar electric vehicle steering plans that. The vehicle steering components that I had to buy at a hardware store, or design, cut, and build are as follows:

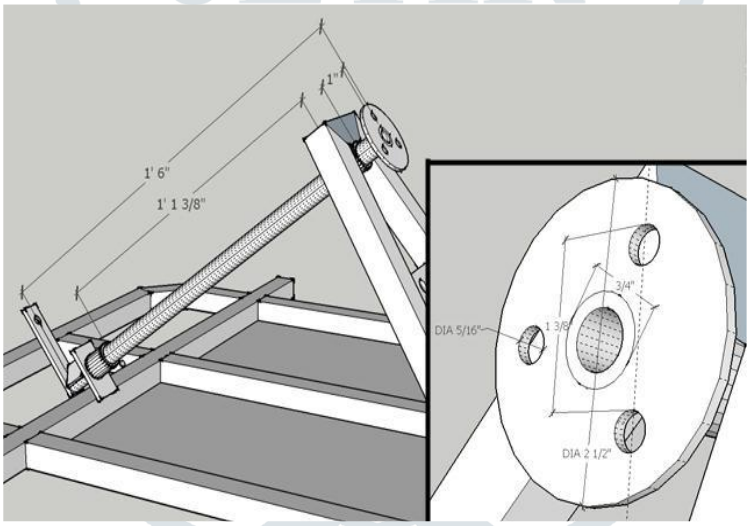

Figure 4.2 Steering System Assembly

Steering Column

- Tubing for the steering shaft.
- Steering wheel hub made from a flat washer.
- Bushings (a.k.a spacers or sleeves) to hold the steering shaft in place under the steering hoop as well as against the lower bracket.

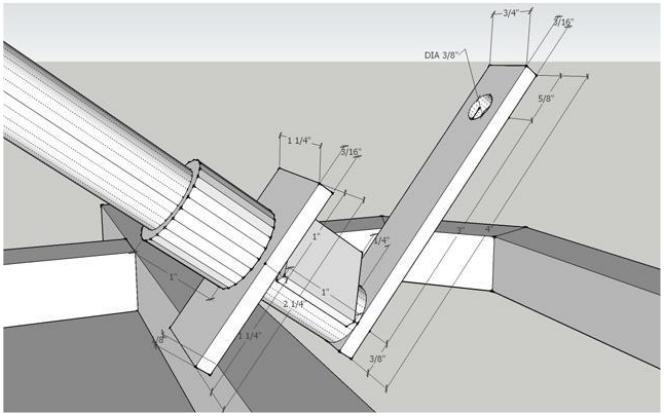

Figure 4.3 Steering Column

Lower Bracket, Steering Stop & Pitman Arm

- 3/16″ plate was used to make the lower bracket and pitman arm.
- 1″x1″x1/8″ thick angle iron was used for the steering stop.

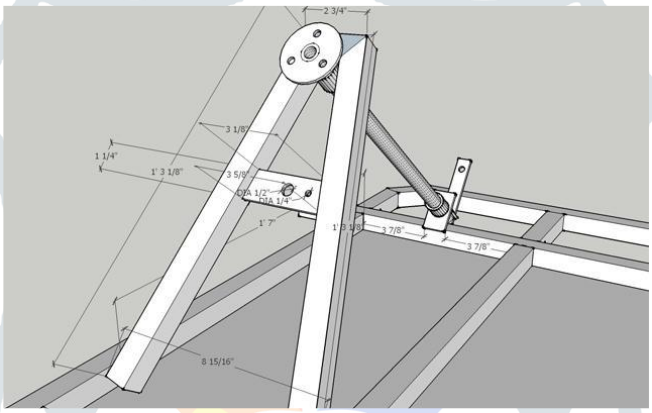

Figure 4.4 Steering Hoop

V. CONCLUSION

From the research point of view, interesting contributions have been presented by researchers in two years like solar photovoltaic powered, zero-emission electric vehicle and solar/wind powered hybrid electric Vehicle, with an internal combustion engine was proposed. A hybrid system for an electric Vehicle is proposed, including solar photovoltaic, storage battery and super capacitor, with the system configuration and different control strategy. The vehicle involving battery powered and charged by photovoltaic panels is used for agricultural activities in remote hilly areas, with the aim to produce the cleaner power hence the usage of diesel is reduced in agriculture. Other hand, many solar vehicles are built to participate in different solar vehicle championship around the world to test and examine the new technological advancements and its potential to design the zero-emission vehicles.

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Different mechanical based four-wheel system already existing in vehicle is: The bevel gear is used in the four-wheel steering mechanism. As two bevel gears are considered, one bevel gear is attached to the steering column of the front steering box and the

other bevel gear is attached toothed intermediate shaft. Use of bevel gear causes system more expensive, while it should be precisely mounted to avoid wear of tyre. Along with bevel gear universal joints with steering knuckle are used.

We have made rear wheel movable by the help of steering system and due to that we have also connected both these by the help of link that are further connected to steering wheel to provide effective turning to the vehicle. We have used linkage in terms of steering because of the compact size of the modal. For turning or as we can also say that for turning which is arranged to maximum torque can be exerted over the link to move the Mechanism. We have use L-type link to play the mechanism and we connect a simple link to the L-type link to make the mechanism free to more.

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